KIPAHOEHOE NATURAL AREA RESERVE

MANAGEMENT PLAN

State of Hawaii
Department of Land and Natural Resources
Division of Forestry and Wildlife
Natural Area Reserves System

2002

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Background

In 1970, Hawaii passed the Natural Area Reserves Law (HRS 195-1), mandating that a Natural Area Reserves System be developed to "preserve in perpetuity specific land and water areas which support communities, as relatively unmodified as possible, of the natural flora and fauna, as well as geological sites, of Hawaii." The Kipahoehoe Natural Area Reserve (NAR) was established in October,1982 for protection of natural features and native ecosystems occurring in the Reserve.

This plan was drafted in accordance with the Management Policies of the Natural Area Reserves System, pursuant to HRS 195-7, which states that management plans addressing biological, social and cultural concerns will be drafted for each Reserve, and will be subject to public comment through the Environmental Review process.

This plan contains material adapted from two previous documents: the Kipahoehoe Natural Area Reserve Resource Information Notebook, prepared by The Nature Conservancy of Hawaii Heritage Program in July 1989, and the Kipahoehoe Natural Area Reserve Management Plan prepared by the Natural Area Reserves System in November 1989. Additional information was gathered as NAR staff conducted surveys and management in the Reserve from 1996 onward.

Scope

This plan addresses only the portion of the Reserve located above Highway 11 -- approximately 80% of the Reserve, which has a total area of 5,583 acres. A supplement for the coastal portion of the Reserve may be written at a later date.

This plan is based on the Special Ecological Area (SEA) approach to managing native ecosystems developed at Hawaii Volcanoes National Park. This strategy limits intensive management activity to areas of high biological value, and where efforts to protect and restore native species would be most feasible. As explained in the plan, only a portion of the Reserve would be designated as a SEA. Little, if any active management would take place in the remainder. This approach is the most realistic, given the limited resources available for management of the Natural Area Reserve System.

The following are some criteria used to evaluate a potential SEA. Intactness of the native ecosystem, rarity and/or degree of threat to the ecosystem/plant community, presence of rare species, value for research, education and as a representative example of a particular ecosystem, feasibility of actually implementing management actions, and clearly defined boundaries.

This plan consists of four parts:

- A general description of the physical characteristics of the Reserve, followed by a detailed description of each of the major plant communities found there. Important biological resources, and threats to these communities are identified.
- A prioritized list of management actions intended to alleviate some of these threats.
- More detailed information about these management actions, and a discussion of some of the issues associated with the proposed actions.
- Appendices with maps of the Reserve, including vegetation types, proposed developments, and boundaries of proposed SEA. Also, lists of plant and vertebrate species found within the Reserve.

General Information

The Kipahoehoe Natural Area Reserve is located in the South Kona district of the island of Hawaii. The NAR encompasses most of the traditional *'ahupua'a* of Kipahoehoe, a 5,583 acre wedge-shaped section of the southwestern slope of Mauna Loa. The parcel includes roughly 2 miles of shoreline, and narrows to less than a mile across at the top of the Reserve, at 5,600' elevation.

Yee Hop Ranch borders the Reserve to the north, south and east. Also to the east is undeveloped land owned by the Damon Estate (Kahuku Ranch). A small parcel of unencumbered State-owned land borders the NAR to the south, between 5,500' and 5,600' elevation. The only public access to Kipahoehoe is from Highway 11, which crosses the NAR at the 1,400' elevation.

A variety of native and non-native plant communities are found within the Reserve. Most of the vegetation above Highway 11 can be described as mesic to wet *'ohi'a* (Metrosideros) forests in an early stage of succession on recent (<2000 years old) *'a'a* lava flows. Within these geologically recent areas are several *kipuka* of older substrate that support diverse, taller forest on deeper soils.

For the purposes of this plan, seven different vegetation types were identified, as shown on the maps in Appendix A. The following section contains a brief description of each, including location and extent within the Reserve, threats to this plant community, and a discussion of management actions that could be taken to alleviate these threats. Vegetation community classifications are adapted from those described in The Nature Conservancy's Hawaii Heritage Database.

Plant Communities of the Kipahoehoe Natural Area Reserve

'Ohi'a and 'Ohi'a/'Ie'ie Lowland Forest

This plant community occurs in a narrow belt along Highway 11. The upper extent appears to be 1,600' elevation, where it grades into *'Ohi'a/Uluhe* forest. This forest type occupies roughly 300 acres within the Reserve.

'Ohi'a is the dominant tree, reaching up to 80 feet in height, with *kolea* (Myrsine), *kopiko* (Psychotria), and *'alahe'e* (Psydrax) the most common understory trees. *'Ie'ie* (Freycinetia) vines are locally abundant, and often form a thick tangle on the forest floor. In areas without *'ie'ie*, the forest understory is comprised of low ferns and shrubs growing in a substrate of mossy *'a'a* lava.

This plant community is relatively common in Hawaii, occurring on most of the main islands.

No rare plants have recently been recorded in this section of Kipahoehoe, but some might be located in a systematic search of the area. Rare plants seen in similar habitat nearby include *'ahakea* (Bobea timoniodes), *'ohe makai* (Reynoldsia sandwicensis), *mehamehame* (Fleuggea neowawraea) and Neraudia ovata (no common name.)

This area has fair to poor value as native bird habitat, due to diseases carried by mosquitoes and non-native birds common at this low elevation. The *'opeapea* or Hawaiian bat (Lasiurus cinereus semotus) is locally common.

Threats:

The primary threat to this plant community is the continued spread of non-native plants, particularly christmasberry (Schinus) from the corridor of disturbed forest along the highway. At present, weed invasion is minimal at distances greater than 100 meters from the road. Many non-native plants established in this area are commonly spread by wind or birds.

Introduced plants such as *kukui* (Aleurites), *ti* (Cordyline), coffee (Coffea), and guava (Psidium guajava and cattleianum) have replaced native vegetation in several small *kipuka* that were once used for agriculture. While these plants are generally restricted to areas with deeper soil, some have the potential to colonize the surrounding lava flows or invade the undisturbed *'ohi'a* forest.

Highway 11 bisects the Reserve at this elevation in this area; there is a possibility that discarded cigarettes could start wild fires. Fire prone non-native grasses such as molasses grass (Melinis) occur along the road edges; if they become established in the forest, the potential for severe fires would increase.

Several pull-outs along the highway have become dumpsites for trash and yard waste. Seeds or cuttings of noxious species could take root and spread into the forest from these points. It is likely that marijuana growers access the Reserve from the highway as well; possibly introducing new weed species with soil in grow bags.

Hunting access to this area from the highway is excellent. However, the extremely rugged and rocky terrain makes it difficult and dangerous for hunters and their dogs to travel any significant distance from the road. Feral pig disturbance appears to be confined to the deeper soils in the *kipuka* mentioned earlier. The native elements in these areas have already been significantly degraded, and reducing animal populations seems unnecessary.

Management recommendations:

The terrain in this part of the Reserve is so rugged that any management activity would be difficult and hazardous. The rough lava and dense tangle of 'ie'ie vines provide an effective barrier to animals and humans. This plant community is not considered rare. It is threatened by the gradual spread of non-native plants, but appears to be in no immediate danger. Limited resources should be directed to managing more significant areas at higher elevation.

Some management actions appropriate in this area include:

- Regular monitoring and control of noxious weeds along the highway to prevent the establishment of new species.

- Development of a parking area and short loop trail into the forest above the highway. This would be combined with development of interpretive materials, and non-native plant control to preserve a representative sample of forest. This native lowland forest could become a valuable site for environmental education. Trail development would also improve hunting access into the lower Reserve. Construction and a possible alignment for this trail are discussed later in the plan.

Exotic Vegetation

Forests dominated by non-native species can be found in a few small areas where human activity was concentrated. Forest clearings for small farms or house sites were often made in *kipuka* with deep soil, generally at elevations below 2500'.

With the cessation of farming, non-native plants have invaded the disturbed areas, and in many cases mature forest has developed. Typical tree species include guava, *kukui*, coffee, rose apple (Syzygium jambos), mango (Mangifera indica), and christmas berry.

Threats:

These pockets of introduced trees may be susceptible to invasion by other non-native plants if further disturbance occurs.

Management recommendations:

No action seems necessary as these areas are of little biological value. Archaeological features such as trails, house sites and agricultural walls are likely to be found here. Human activity should be discouraged in these areas to prevent damage to such sites.

Pioneer Vegetation on Recent Lava Flows

This plant community is found on the 1919 'Alika lava flow that runs along the southern boundary of the NAR, and on the 1950 Ka'apuna lava flow which covers a small area at the northeast corner of the Reserve. It occupies roughly 600 acres. Recent lava flows with similar vegetation are common at higher elevations on Maui and Hawaii.

Vegetation on the flow varies with elevation. Near the top of the Reserve, the ground is nearly barren. At lower elevations, a ground cover of lichen and moss is common, interspersed with the sedge *'uki* (Machaerina), *'ama'u* (Sadleria) and *uluhe* (Dicranopteris) ferns, shrubs such as *'ohelo* (Vaccinium), *pukiawe* (Styphelia), *na'ena'e* (Dubautia), *kukaenene* (Coprosma) and sapling *'ohi'a* trees.

Rare plants are unlikely to occur on these recent lava flows.

The scattered small trees offer fair habitat for native forest birds. 'Amakihi and 'apapane are commonly observed on the flows.

Threats:

The harsh conditions on the recent lava flows have so far discouraged the establishment of most non-native plants. Non-native grasses that could invade this habitat include fountain grass (Pennisetum setaceum), beardgrass (Schyzachrium) and broomsedge (Andropogon). Colonization by grasses could interfere with native plant succession, and create a fire hazard.

Browsing damage from feral goats and sheep is apparent at higher elevations. They appear to feed preferentially on certain native plants, altering the natural composition of this forest. Feral pigs do not often cross this rough terrain.

Management Recommendations:

No action is feasible at this time. This plant community is not rare, nor is it immediately threatened. Increased goat hunting might reduce damage to native vegetation to some extent. The only way to permanently remove goats from the area would be to fence the entire Reserve, otherwise they will continue to enter from adjacent private lands. A portion of this community would be protected by the fencing scheme proposed later in the plan.

Highway 11 and the 4 wheel drive roads that cross the Reserve should be monitored for invasion of the fire-prone grasses mentioned above.

'Ohi'a/Uluhe Forest

This plant community occupies the majority of the Reserve between 1600' and 4600' elevation; about 2500 acres. It represents an early successional stage of *'ohi'a* forest on a recent (between 200 and 750 years old) lava flow that covered most of Kipahoehoe.

The forest is comprised of *'ohi'a* trees emerging from a dense mat of *uluhe* (Dicranopteris) fern. Beneath the fern is an extremely rugged *'a'a* flow. Other native plants found here include some that grow on the recent lava flows, as well as young *kopiko*, *'olapa* (Cheirodendron), *kawa'u* (Ilex), and *kolea* trees. Small pockets of *'Ohi'a Montane Wet Forest* occur within this fern forest.

This vegetation type is common in Hawaii, and occurs on all the main islands. This forest is still too young to support much plant diversity to have developed; rare species are unlikely to be found here. The dense stands of small diameter *'ohi'a* offer good habitat for the more common native birds.

Threats:

The dense mat of *uluhe* fern prevents the establishment of most non-native plants. Above 2500' elevation the forest is essentially weed free.

The combination of thick *uluhe* and the rough lava beneath make this portion of the Reserve virtually impenetrable to pigs, goats, and human beings.

While this area is usually damp, drought conditions can make the *uluhe* an extreme fire hazard. Were a fire to start in this portion of the Reserve, it would be difficult and costly to extinguish.

Management Recommendations:

No action seems necessary or feasible. This plant community acts as a barrier protecting more sensitive areas, and can be utilized as a "natural fence."

'Ohi'a Montane Mesic - Wet Forest

This community occurs in the Reserve in the lower reaches of the *Koa/'Ohi 'a Forest kipuka*, and in a narrow strip of older soil south of the 1919 flow, between 2200' and 3000' elevation. It comprises at most 300 acres of the NAR.

'Ohi 'a up to 80 feet tall are dominant in this forest, with a subcanopy layer that includes *kopiko*, *kolea*, *kawa 'u*, *'olapa*, *mamaki* (Pipturus) and *olomea* (Perrotettia). Below this is a dense layer of *hapu 'u* (Cibotium) and a diverse understory of native shrubs and ferns.

This plant community occurs on most of the main islands, and is widespread on the island of Hawaii.

Rare plants such as native mints (Phyllostegia and Stenogyne) are likely to occur here, as well as the lobeliads Cyanea and Clermontia.

This dense forest is important habitat for native birds, especially at elevations above the range of disease carrying mosquitoes.

Threats:

Feral pig disturbance is widespread in this forest type. Evidence of feral cattle was observed in the *kipuka* south of the 1919 flow.

This community is vulnerable to invasion by a variety of non-native plants, especially guava and banana poka, which are often spread in the feces of feral pigs.

Management Recommendations:

The *'Ohi 'a Forest* in the *kipuka* above 3800' elevation is heavily disturbed by pigs, but few weed species are established here. The surrounding *'Ohi 'a/Uluhe Forest* has acted as a barrier to weed spread; preventing ingress of animals from weed infested areas. Reducing pig activity in the *kipuka* is essential to maintain the health of this forest, and is discussed under specific management actions.

The small strip of forest south of the 1919 flow, however, is heavily infested with non-native plants. Pigs and cattle have destroyed most of the natural understory. Encouraging public hunting in this area might reduce animal damage. Hunting (with dogs) is allowed here, although few (if any) hunters use the area, as the only public access requires a one-mile hike over *'a 'a* lava. The boundary between the NAR and adjacent Yee Hop Ranch is not marked. Short of constructing a fence, there is no way to ensure that hunters and their dogs do not trespass onto private property. Developing an access and constructing a boundary fence would be a gesture of goodwill to the hunting public and the Ranch. However, the expense of surveying the boundary and building 1¼ mile of fence through dense forest would be more than the benefit expected from reducing pig numbers in a small pocket of forest already invaded by noxious weeds.

Koa/'Ohi'a Montane Mesic - Dry Forest

This plant community is found in four *kipuka* of older substrate (>2000 years) between 3800' and 5400' elevation. It occupies roughly 550 acres of the Reserve. The *kipuka* have been labeled "North", "Middle", "South" and "East" on the maps in Appendix A.

This forest type is the most impressive and diverse in the Reserve. Giant *koa* trees (as large as 100' tall and up to 8' in diameter) tower over an *'ohi'a* canopy up to 80' high. The subcanopy is diverse, and contains large specimens of *kolea, kopiko, kawa'u, 'olapa, naio* (Myoporum), *ho'awa* (Pittosporum), *'alani* (Melicope) and other trees. At lower elevations and in wet areas, *hapu'u* forms an additional canopy layer. In areas not disturbed by animals, the ground is covered with a dense growth of such ferns as Dryopteris, Diplazium, Pteris, the sedge Uncinia, the succulent herb *'ala'alawainui* (Peperomia) and the native lily *pa'iniu* (Astelia). With increasing altitude, the climate becomes drier, tree ferns are less abundant and are replaced by *'akala* (Rubus) shrubs. Trees develop a gnarled habit, and *naio* becomes a more common component of the forest.

This forest community occurs on Maui, Hawaii and Kauai. Nearly 90% of the original range on Hawaii has been severely degraded and deforested. Cattle ranching, logging, fire, feral ungulates, and invasion by non-native plants threaten most of the remainder.

This is important and essential forest habitat for at least four endangered birds. The endangered Hawaii Creeper, *'akepa* and *'akaipola'au* have been observed in similar habitat nearby, and may be present within the Reserve. Kipahoehoe is considered essential habitat for the *'alala*, although none have been seen here recently.

This diverse forest is habitat for several species of rare plants. The endangered native lobeliads Cyanea hamatiflora and Cyanea stictophylla, have been found here recently, as well as the mints Stenogyne macrantha, Phyllostegia floribunda, and the shrub Rubus macraei.

Threats:

The primary threat to this forest community is the damage caused by feral pigs and goats. Pig disturbance of the soil and understory vegetation is causing erosion, eliminating certain sensitive plant species, and creating conditions favorable for the establishment of non-native weeds. Goats have heavily grazed the North, South and East *Kipuka*. As a result, non-native grasses have replaced the native understory vegetation, primarily rice grass (Ehrharta) and kikuyu (Pennisetum clandestinum). The thick mat of grass prevents the regeneration of native plants. Goats continue to girdle and kill small diameter trees. They feed preferentially on trees such as *koa, naio* and *pilo*. If grazing continues, these species may disappear from the forest as older trees die and are not replaced.

Cattle grazing is taking place on the Ranch property adjacent to the North *Kipuka*. A log barrier constructed to exclude cattle is in disrepair, and cattle regularly trespass into the Reserve.

With the exception of pasture grasses in disturbed areas, the *kipuka* are nearly free of non-native plants. The remote location of the area, and the barrier of surrounding lava flows and *uluhe* fern have kept many troublesome weeds from becoming established. Non-native plants that have invaded similar forests elsewhere include guava, banana poka and granadilla (Passiflora mollisima and ligularis), blackberry (Rubus argutus), and German ivy (Senecio mikanoides).

Koa logging is taking place on the private lands adjacent to the Reserve. The boundary between State and private lands is presently unmarked. If logging were to take place in this area, trees may be taken from within the Reserve.

Management Recommendations:

Cattle, pigs, sheep and goats must be removed from the upper Reserve to prevent further damage to the forest and allow natural regeneration to begin. Native plants would rapidly recolonize many of the disturbed areas once animals were removed, and creation of animal free sanctuaries would allow reintroduction of rare plant species that once grew here. This will require construction of a system of animal proof fences, and systematic hunting to remove all animals from within the fences. The specifics of this are discussed later in the plan.

The boundary between the NAR and Yee Hop Ranch needs to be surveyed and marked in the upper portion of the Reserve. This will allow construction of animal proof fences along the boundary, and will prevent the possibility of *koa* being taken from State land.

Control of non-native plants should be started. The focus should be on preventing invasive weeds from becoming established in the interior of the *kipuka*. For example, small populations of German ivy have been located in the North and Middle *Kipuka*. It is important to eliminate this plant before it spreads farther within the Reserve.

'Ohi'a Dry Forest and Montane Shrubland

These communities occupy approximately 250 acres at the very top of the Reserve (5,200' to 5,500'.) They occur on the same lava flow substrate that is occupied by *Ohi'a/Uluhe Forest* at lower elevation. Vegetation is primarily stunted *'ohi'a*, native shrubs such as *pukiawe*, *'ohelo* and *'a'ali'i* (Dodonea.) The native sedges Carex and Gahnia, native grasses such as Deschampsia and Agrostis, lichens, and ferns are typical groundcover. A few small kipukas within the shrubland contain small groves of taller *'ohi'a*, with the same understory species.

This plant community is common on Hawaii and Maui.

No rare plants are known to occur in this part of the Reserve.

This low stature forest provides good habitat for common native birds, and is located well above the range of disease causing mosquitoes.

Threats:

Non-native plants have not yet become widely established at this high elevation.

Feral goats are causing moderate damage. They selectively browse some native species. Goats also trample and scuff up dirt to make bedding areas. Non-native species, particularly grasses, often invade these disturbed areas.

Management recommendations:

This plant community does not appear to be in immediate danger, nor is it considered rare. Removing goats would prevent further damage to native plants. This could be partially accomplished while protecting *Koa/'Ohi'a Forest kipuka* as described below.

Regular monitoring and removal of new weed species, particularly fire-prone grasses, should be implemented along roadsides.

Proposed Management Actions

The most important features of the Kipahoehoe NAR are the four *kipuka* of *Koa/'Ohi'a* forest at the upper elevations. They represent one of the few remaining examples of this plant community in the State not significantly disturbed by cattle or logging. These *kipuka* contain several rare plant species, and are important habitat for native forest birds, including endangered species. The actions outlined in this plan would treat the portion of the Reserve containing these *kipuka* as a Special Ecological Area. Management of the Reserve would be primarily oriented to protecting this area of high biological value.

Specifically, this plan calls for constructing a system of animal proof fencing and permanently removing pigs, goats, cattle and sheep from the entire Reserve above the 3,600' elevation, an area of approximately 1,600 acres. This represents less than one-third of the Kipahoehoe NAR. In the remainder of the Reserve, public hunting would continue to be the primary method by which feral ungulate numbers were controlled.

These fences would be aligned in such a way as to use existing roads and natural barriers as much as possible. Some new road construction would be required for the fence lines. Construction of an access road to the upper Reserve may also be necessary.

Also presented in this section are the methods by which feral animals would be removed, a discussion of how public access (for hunting and non-hunting recreation) to the Reserve could be improved, and an outline of non-native plant control strategies.

Prioritized List of Management Actions

Management Unit: Middle Kipuka

Creating this unit would require construction of a 1,200' foot fence line along an existing road at the 4,400' elevation, across the Middle *Kipuka*. See map in Appendix A. The ends of this fence line tie into the dense *uluhe* fern surrounding the *kipuka*. This creates an enclosed unit of roughly 150 acres below the road, with the *uluhe* fern acting as a natural barrier around most of the perimeter.

This fence was completed in early 1998. There are no longer goats within the fenced area. As of this writing no pig control has been done, but remains a high priority for this unit.

Boundary Survey

Many of the roads and fences proposed in this plan would follow Reserve boundaries. Before they can be constructed, the boundary needs to be formally surveyed. Marking the Reserve boundaries is an important first step in preventing cattle trespass or removal of *koa* from the Reserve.

The portion of the Reserve most needing survey includes the north and south boundaries from 3,600' elevation to the top, and the entire eastern (or upper) boundary. Total distance is approximately 5½ miles. Most of this distance will be along existing roads, or across open pasture and lava fields, so this survey should be easy to conduct.

Management Unit: Upper Koa Forest

This unit would be completely enclosed by fences, and would not rely on natural barriers. It would be roughly triangular in shape, and would comprise 350 acres. The upper portions of the North, Middle and South *Kipuka* would be included in this unit, as well as some of the 1919 flow and *'Ohi'a Dry Forest and Shrubland* community.

The lower unit boundary will be the 4,400' contour road. The north side of the unti will follow the Reserve boundary between 4,400' and 5,200'. The third leg of the triangle follows the existing Koa Mill Road which makes a diagonal across the upper Reserve.

Most of this fence would be constructed along existing roads, or through pasture, with the exception of 900 feet that would traverse the 1919 flow along the south Reserve boundary in order to connect the Koa Mill road with the 4,400' contour road.

The present road along the north side of the NAR does not follow the actual boundary. It follows a log barrier that lies approximately 100 to 150 yards inside the Reserve. The +/-50 acre area of the NAR outside the barrier is still being used as pasture.

Two different alignments could be chosen for a fence along this boundary. The first choice would be to use the existing road as an informal boundary. This would essentially "donate" the 50 or so acres of the NAR presently being grazed to the Ranch.

The second choice would be to formally survey and construct a new road and fence along the actual boundary. This would allow all of the NAR to be removed from grazing. The pasture area has been severely disturbed; of the original forest, only scattered trees remain. If cattle were removed, the pasture could be replanted with native trees. This would be the more expensive of the two choices, as it would require survey and construction of approximately one mile of new roadway. However, in the long run this would be preferable to using the existing road. Formalizing the boundary will remove a potential source of friction with the Ranch, and allow restoration of native forest in a significant portion of the Reserve.

Management Unit: North Kipuka

This unit would require 1¼ mile of fence to be constructed on existing roadway along the North Reserve boundary between 4,400' and 3,600' elevation. It would enclose 100 acres, with the *uluhe* fern acting as a natural barrier on one side. As with the Upper *Koa* Forest unit, this roadway does not follow the true boundary. The actual boundary will need to be surveyed and a new road constructed, or a portion of the Reserve will be left unfenced.

Management Unit: South Kipuka

Enclosing this unit will require approximately 1¼ mile of fence. This fence would begin at the 4,400' elevation road and run down to 3,600' where it would end in the dense *uluhe* below the South *Kipuka*. Roughly 100 acres of the south *kipuka* will be protected by this fence. In order to build the fence, new roadway would have to be constructed on the 1919 flow along the *kipuka* edge. This roadway would be incorporated into the *makai* access road described later.

3600' Contour Road and Fence Construction: Lower Koa Forest Unit

As described above, the North, Middle and South *Kipuka* management units all rely on strategic fences tied into patches of dense *uluhe* fern. This fern growth is effective as a natural barrier to goats and sheep, but pigs may occasionally tunnel under it. Because of this, these three management units will always be vulnerable to incursion by pigs. A concerted hunting/snaring program in the three *kipuka* will greatly reduce pig numbers, but in the long term, it makes more sense to completely surround these units with fences, and permanently remove animals from the enclosed area.

Enclosing this area requires construction of a new road across the Reserve at the 3,600' contour; a distance of 1¼ miles. A fence along this road will join with the lower ends of the North and South *Kipuka* fences. This will create a single fenced unit of 1000 acres.

This road would cross extremely rough terrain and dense *uluhe* fern, and may be difficult and hazardous to construct. This, and the impact to the forest that will result from building a road through undisturbed vegetation, would ordinarily make it a last resort.

However, there are other factors that make this road desirable. Presently, a wildfire starting at lower elevation (from Highway 11) could burn upslope through the dense fuels of *uluhe* fern and into the valuable *kipuka* forests. A road across the Reserve below the *kipuka* would provide an important fuel break in case such a fire did occur.

Second, this road/fence will provide a distinct boundary between the upper Reserve, which will eventually be closed to public hunting (except for supervised animal removal), and the lower Reserve, which will remain open.

Third, an access trail could be made from this road to the lower end of the Middle *Kipuka*. This would greatly improve access for weed control, outplanting, etc. to an area that can presently only be reached by a long hike.

This road would displace roughly 3 acres of native vegetation (20 foot wide corridor, 1¼ miles long). This would be primarily *uluhe* fern and young *'ohi'a* trees. It is unlikely that any rare plants would be damaged. As stated earlier, the *'Ohi'a/Uluhe* community is not considered rare, nor does it have a high diversity of plant species.

Management Unit: Mauka Shrublands

This unit includes the uppermost 250 acres of the Reserve. It contains 100 acres of the East *Kipuka* owned by the State of Hawaii, as well as 150 acres of *'Ohi'a Dry Forest and Shrubland* and portions of the 1919 and 1950 lava flows. Two miles of fence would be required to enclose the top of the Reserve. The lower boundary of this unit would be the fence along the *mauka* road across the Reserve.

This fence would cross rugged, roadless terrrain, and will be difficult and expensive to install. A new road built around the Reserve perimeter would make construction of this fence easier. However, in the interest of reducing impacts to the area, it is recommended that a perimeter road only be built on recent lava flows, and not over older substrate with well developed vegetation. In these areas, a helicopter would be used to ferry fence material to the site, and possibly to unroll the fence wire.

Makai Access Road

At the present time, Highway 11 is the only formal access to the Reserve. The upper portion of the Reserve, which contains the most significant biological resources, can only be reached by helicopter, by use of private roads on neighboring Yee Hop ranch, or by hiking up the 1919 lava flow; a round trip distance of over 10 miles.

Since 1998, Yee Hop Ranch has allowed limited access to the NAR via private roads in the adjacent Alika tract. Only DLNR personnel on official business have been allowed to use this access, dependent on the availability of the Ranch manager to open gates and process waivers of liability. Use of these roads is based on an informal agreement, and can be denied at any time.

This arrangement has been sufficient to date, although planned work trips have been cancelled when there was poor communication (gate not open) or conflict with activities on the Ranch. Successful implementation of this management plan requires continued good relations and cooperation with the Ranch. However, relying solely on this limited access could slow the implementation of this plan, especially if fences are to be built by a private contractor.

The present limited access has already proved to be an impediment to planned animal control activities. The Ranch is unwilling to allow public use of private roads to get into the NAR, and has asked that hunting dogs not be used for feral animal control, citing concern that dogs may trespass into their pasture and interfere with cattle. These restrictions make it essentially impossible for public hunting (the preferred method) to be effective in removing animals from the upper Reserve.

If, at some point in the future, this access to the upper Reserve becomes inadequate, consideration should be given to construction of a new access road, entirely on State land. The most feasible route for this road would be up the 1919 flow. It would follow the southern NAR boundary from Highway 11 uphill to the 4800' elevation, where it would join existing roads. The access road would be 5 miles in length. Half of this distance would incorporate existing segments of abandoned jeep trail. The South *Kipuka* unit fence would be installed along a portion of this road.

In order to minimize problems such as trespassing and illegal hunting on the Ranch, as well as fires, illegal dumping, marijuana cultivation, and accidental introductions of weed species into the Reserve, it is recommended that the access road be closed by a locked gate at the highway. Foot traffic would be unrestricted, but vehicular access would be by permit only. Gates and signage would also need to be placed on some of the existing *mauka* roads to prevent trespass onto the Ranch.

Mauka Access Road

There has recently been increased interest on the part of entities such as the US Fish & Wildlife Service, the National Park Service, and the Nature Conservancy in protecting native ecosystems in the South Kona region. Several parcels of land in the vicinity have recently traded hands, and are now being managed for native forest conservation.

It is likely that trend will continue. The lands of Kahuku and Papa 1-2, which lie to the south and east of Kipahoehoe, have been suggested as possible conservation acquisitions. If this takes place, the result will be creation of a large, contiguous block of land owned by a variety of public and private conservation entities. Conservation endeavors in the region will be much more efficient and effective if the respective land managers cooperate in developing access roads, as well as strategies for fencing, fire suppression, and feral animal and weed control.

If Papa 1-2 and/or Kahuku do change hands, and the new owners are cooperative, a road could be built that crosses the unencumbered parcel of State land at Alika (above Yee Hop Ranch), and enters Kipahoehoe at the Southeast corner of the Reserve. Access from Highway 11 would be over existing roads across State and Nature Conservancy lands at Honomalino.

At present, this potential access route to the NAR is wishful thinking at best. However, it is important to include it in this plan, because if it becomes feasible, it will be the best possible way to access the upper Reserve.

As discussed earlier, the present access through Yee Hop Ranch is inadequate for the long term. The proposed *makai* access is entirely within the NAR, but could potentially create new problems due to increased public traffic in the Reserve. This third, *mauka* access would cross land owned by parties sympathetic to the conservation goals of the Natural Area Reserves System, and hence more likely to allow fence contractors, hunting parties, etc. to pass through. The lower section of this route, which crosses State and Nature Conservancy lands at Honomalino, is gated and not open to the general public. If the road is extended into upper Kipahoehoe, it is unlikely that trespassing will become a problem.

A map of the improvements proposed in this section can be found in Appendix A. Further discussion of issues related to these management actions follows in the next portion of the plan.

Management Shelter Construction

Due to the remote nature of the Reserve, workers involved in fence construction, weed control, and other activities will often need to camp on site. Construction of a simple shelter near the top of the Reserve will make it easier for crews to work efficiently. A small, open sided 'pavilion' with a wooden deck floor; 400 to 600 sq. ft. area under roof should be sufficient.

Runoff from the roof would fill a water tank of 1000 to 1500 gallons. This water would be used for showers, herbicide mixing and clean-up, irrigation of rare plants, etc. This water supply would also be valuable in the event of a fire. To keep the area sanitary, it will also be advisable to construct a small outhouse for a pit or composting toilet.

Constructing a shelter will confine some human impacts to an area that can be 'hardened' to accommodate them. It will increase productivity of work crews by reducing the amount of equipment required to camp on site, as well as the vehicle traffic needed to haul this equipment.

Discussion of Issues Relating to this Plan

Fence Construction

Fences proposed in this plan would be built of galvanized woven hog wire. In areas where pigs are likely to be present, a strand of barbed wire will be placed at ground level. To prevent goats and sheep from jumping over the wire, one or two strands of barbed wire will be attached above the hog wire. The wire will be clipped to galvanized "T" posts, spaced 8' to 10' apart. Wire skirts and anchor pins will be placed along the line to block any gaps that would allow pigs to pass under the fence. For additional security, the fence will be reinforced every 100' with line posts of treated wood or metal pipe. Pipe or posts will also be used for braces at all major bends and corners.

A fence made from 47" hog wire topped with barbed wire (for an effective height of 6 feet) would be sufficient to exclude goats and pigs. Mouflon sheep, originally released at Kahuku Ranch in the late 1960's, have expanded their range beyond the original release site. In recent years, they have been observed inside Hawaii Volcanoes National Park, indicating that they can cross six foot high fences. The Park now must undertake an expensive modification of their fence lines. Mouflon are uncommon in the vicinity of Kipahoehoe at present. However, in the absence of a control program, it is only a matter of time before their range expands to fill all suitable habitat on Mauna Loa. If possible, the Kipahoehoe fences should be built tall enough to exclude Mouflon in order to avoid later difficulties. Mouflon proof fencing may need to be 8 feet tall or higher, which will add significantly to the cost and difficulty of implementing this plan.

Most of the fences mentioned in this plan will be installed along existing or proposed roadways. It is possible to install fence on unmodified lava flows, and avoid the environmental impact associated with road construction. However, this will greatly increase the cost and difficulty of the project. Mouflon proof fencing may require 10' long fence posts, which may be impossible to install without an elevated platform (such as a truck tailgate) to work from.

Where feasible, gates or stiles will be installed to aid in crossing the fences.

Road Construction

It is acknowledged that road construction can adversely impact the natural environment. Direct impacts are destruction of vegetation and soil disturbance in the road corridor. Indirect effects include increased potential for the introduction of weeds along the disturbed corridor. The actions proposed in this plan, for the most part, will be restricted to areas that have already been disturbed. Only where it is absolutely necessary will roads be built into undisturbed sites.

The majority of new roads proposed in this plan will be built on recent lava flows. These flows are sparsely vegetated, and rare plant species are unlikely to occur. While certain non-native weeds can be expected to colonize road corridors, most will not readily spread onto undisturbed lava. Regular monitoring and weed control should be sufficient to prevent pests from spreading beyond road sides.

All roads mentioned in this plan would be for 4-wheel drive vehicles only. They would be unsurfaced lava rock, ripped and compacted where necessary. Width will be approximately 16 feet. Where possible, grades will be kept below 15%. Due to the porous nature of the lava rock, culverts or water diversions will be unnecessary.

Before construction begins, all road alignments will be traversed on foot, and changed where necessary, to prevent damage to rare plants.

Public Access

The entire Kipahoehoe NAR is presently open for public (daylight hours) use for hiking, nature study, hunting, etc. However, the rugged terrain and lack of a road and trail system discourage much activity. Due to the sensitive nature of the natural communities at higher elevations, and the potential for trespass onto neighboring private lands, access to the upper Reserve should remain restricted.

The lower portions of the Kipahoehoe NAR are less sensitive, and may be suitable for development of short hiking trails, possibly accompanied by interpretive signs or a trail guide.

One possible alignment for a trail is presented in Appendix A. This route would incorporate remnants of historic trails built for foot and horse traffic. These include what may be a portion of the *ala ehu*; an inland route that circled much of the island, much as the *ala kahakai* circles the coast. The Historic Preservation Division would be consulted before any trail development took place.

Hunting

The entire Kipahoehoe NAR is presently part of Hunting Unit K. Hunting of feral pigs, goats and sheep is allowed year-round, 7 days a week. The daily bag limit is two animals of each species.

Despite these liberal rules, little hunting takes place in Kipahoehoe. This is due to the rugged terrain, dense vegetation, poor access and the sparse population in this part of the island. There are better places to hunt elsewhere in South Kona and Ka'u; Kipahoehoe is rarely visited.

The high level of goat and pig activity in the upper Reserve presents a serious threat to the native forest. A partial solution to this problem would be to develop a public access to the top of the Reserve, and to encourage increased hunting pressure.

As mentioned earlier, this will require construction of a new road; Yee Hop Ranch will not allow the public to traverse their property. If such a road were constructed, trespass and illegal hunting on neighboring private property would undoubtedly become a problem. This could jeopardize the present good relationship with the Ranch.

Special hunts, with NAR staff present to supervise volunteer hunters in animal removal from fenced units would be another option. However, the Ranch has not agreed to this, citing concern of trespass and the possibility of lost dogs interfering with cattle operations. Without building a new access road, the only way to get hunters to the upper Reserve would be by helicopter, which is prohibitively expensive.

If the actions proposed in this plan are implemented, the result will be the withdrawal of approximately 1000 acres from the public hunting area. Game animals will be permanently removed from the within the fenced units. This will not have any significant effect on public hunting opportunities in the South Kona region, because hunters are not using the upper Kipahoehoe area.

In the long run, the hunting public would be far better served if DOFAW were to develop access to other Forest Reserve parcels in South Kona, particularly Honomalino, Kukuiopae, and Opihihali. These tracts are significantly larger than the portion of Kipahoehoe from which animals will be removed. They also contain large expanses of mature forest with open understory; which is much better for hunting than the dense brush of Kipahoehoe.

Feral Animal Control

The primary threat to the native ecosystems in the upper portion of Kipahoehoe is the continuing uncontrolled disturbance and damage to vegetation caused by feral pigs, goats, cattle and sheep. Constructing animal proof fences around the management units described above will prevent ingress from outside the Reserve, but all animals within the fenced areas will need to be removed.

Game drives to chase animals out of areas prior to fence closure may be partially successful, given the small areas to be fenced, and the relatively open nature of the forests at higher elevation. After the drives, some follow up method must be used to ensure that every animal has been removed. Hunting with dogs (using public hunters whenever possible) would be the preferred method, but access problems and the concerns of the Ranch make this not feasible.

Goats, cattle and sheep in the relatively open forest of the upper Reserve will often be visible from a helicopter. Any animals trapped within the fence after game drives could be shot from the air or hunted down on the ground.

Feral pigs will be difficult to drive in areas with dense vegetation. Without hunting dogs, the only feasible method to remove these animals will be through the use of snares. The forested *kipuka* units are small, and should be fairly easy to saturate with a large number snares, in order to remove most of the animals in a short time. The existing system of management transects will allow all snares to be checked efficiently. At the beginning of the snaring program, snares will be checked frequently to reduce the time that animals are left trapped alive. As animal numbers drop, checks will take place less often. When fully enclosed units are known to be pig free, all snares will be removed.

Unless the 3,600' contour fence has been built, enclosing the Lower *Koa* Forest unit, there will always be the possibility of further pig ingress through the uluhe fern into the North, Middle and South *kipuka*. A concerted snaring program will reduce pig numbers, but cannot completely eliminate them. For this reason, it is recommended that this lower road and fence be constructed, creating a single, fully enclosed unit from which all animals can be removed.

If a snaring program is instituted in the upper Reserve, there is a remote possibility that dogs may accidentally be trapped. This risk can be reduced in several ways. Snaring would only take place in units that are enclosed by fences and have warning signs posted. The upper portion of the NAR (above Highway 11) would be closed to hunting with dogs as long as snaring was taking place. Hunting without dogs would be continue in the portion of the Reserve below the fenced units.

Weed Control

The majority of the Kipahoehoe NAR is still relatively free of non-native plant species. Many plants that are pests in similar habitats elsewhere in Hawaii have not yet become established in the Reserve. Any vegetation management program would focus primarily on preventing new introductions. This could be accomplished by regular monitoring of roads, trails and Reserve boundaries, and eradicating incipient populations of weeds before they spread further.

Some problematic weeds, especially Passiflora, Schinus, and Psidium, have already become widespread in the Reserve. Control of these plants would be directed towards reduction/removal in sensitive areas like the *kipuka*. Control in these selected areas would be done by hand-pulling and use of herbicides. If biological control agents for these plants become available, it may be desirable to attempt releases in the NAR.

In portions of the *kipuka* that have been grazed, non-native grasses have become well established. Grass specific herbicides may be effective in suppressing the grasses and speeding recovery of native woody plants.

Rare Plants

As one of the largest remaining tracts of undisturbed native vegetation in South Kona, the Kipahoehoe NAR is an important potential site for the restoration of rare plant (and animal) species.

Several rare plant species persist in the Reserve; others are known from the immediate vicinity. Once feral animals are removed from the upper Reserve, an aggressive program to restore rare species should be pursued. Species selected would be those likely to have occurred in or near Kipahoehoe. When possible, plants would be grown from seed or cuttings collected within the Reserve.

Appendix B lists rare plants that might be appropriate for this restoration program.

Appendix A

Kipahoehoe Natural Area Reserve Management Plan

Project Area Maps

- Reserve Location and Adjacent Landowners
- Vegetation Communities
- Management Units and Proposed Fences
- Proposed Internal Road System
- Access Routes
- Possible Public Hiking Trail Alignment

Appendix B

Kipahoehoe Natural Area Reserve Management Plan

Plant Species Checklists

- Native Plant Species
- Non-native Plant Species
- Status of Rare Plants Proposed for Recovery Program

Appendix C

Kipahoehoe Natural Area Reserve
Bird Species Checklist

The birds listed have been reported from visual and audio identification in or near the Reserve. The list includes information on rare birds, compiled from the literature. Taxonomy follows the Checklist of the Birds of Hawaii by Pyle (1988).

Status	Species	Common Name	Source
X	Acridotheres tristris	Common Myna	*
X	Alectoris chukar	Chukar	x
E	Asio flammeus sandwichensis	*Pueo*; Hawaiian owl	?
E +	Buteo solitarius	*'Io*; Hawaiian hawk	*
X	Cardinalis cardinalis	Northern Cardinal	*
E	Chasiempis sandwichensis sandwichensis	*'Elepaio*	*
E +	Corvus hawaiiensis	*'Alala*; Hawaiian crow	?
X	Geopelia striata	Zebra Dove	*
E +	Hemignathus munroi	*'Akiapola'au*	?
E	Hemignathus virens virens	*'Amakihi*	*
E	Himatione sanguinea sanguinea	*'Apapane*	*
X	Leothrix lutea	Red-billed Leothrix	*
X	Lophura leucomelana	Kalij Pheasant	*
E +	Loxops coccineus coccineus	*'Akepa*	?
X	Meleagris gallopavo	Wild Turkey	x
E +	Oreomystis mana	Hawaii creeper	?
I	Phaethon lepturus dorotheae	*Koa'e kea*; White-tailed tropic bird	*
X	Phasianus colchicus	Ring-necked Pheasant	x
X	Streptopelia chinensis	Spotted Dove	x
X	Tyto alba	Common Barn-owl	*
E	Vestiaria coccinea	*'I'iwi*	*
X	Zosterops japonicus	Japanese White-eye	*

+ = Rare
X = Not Native
I = Indigenous
E = Endemic

* = Confirmed during NARS inventories
x = Cited in literature sources for Kipahoehoe
? = Cited in literature for South Kona area; not confirmed in the Reserve

Taken from Kipahoehoe Natural Area Reserve Resource Information Notebook, prepared by The Nature Conservancy of Hawaii, 1989.

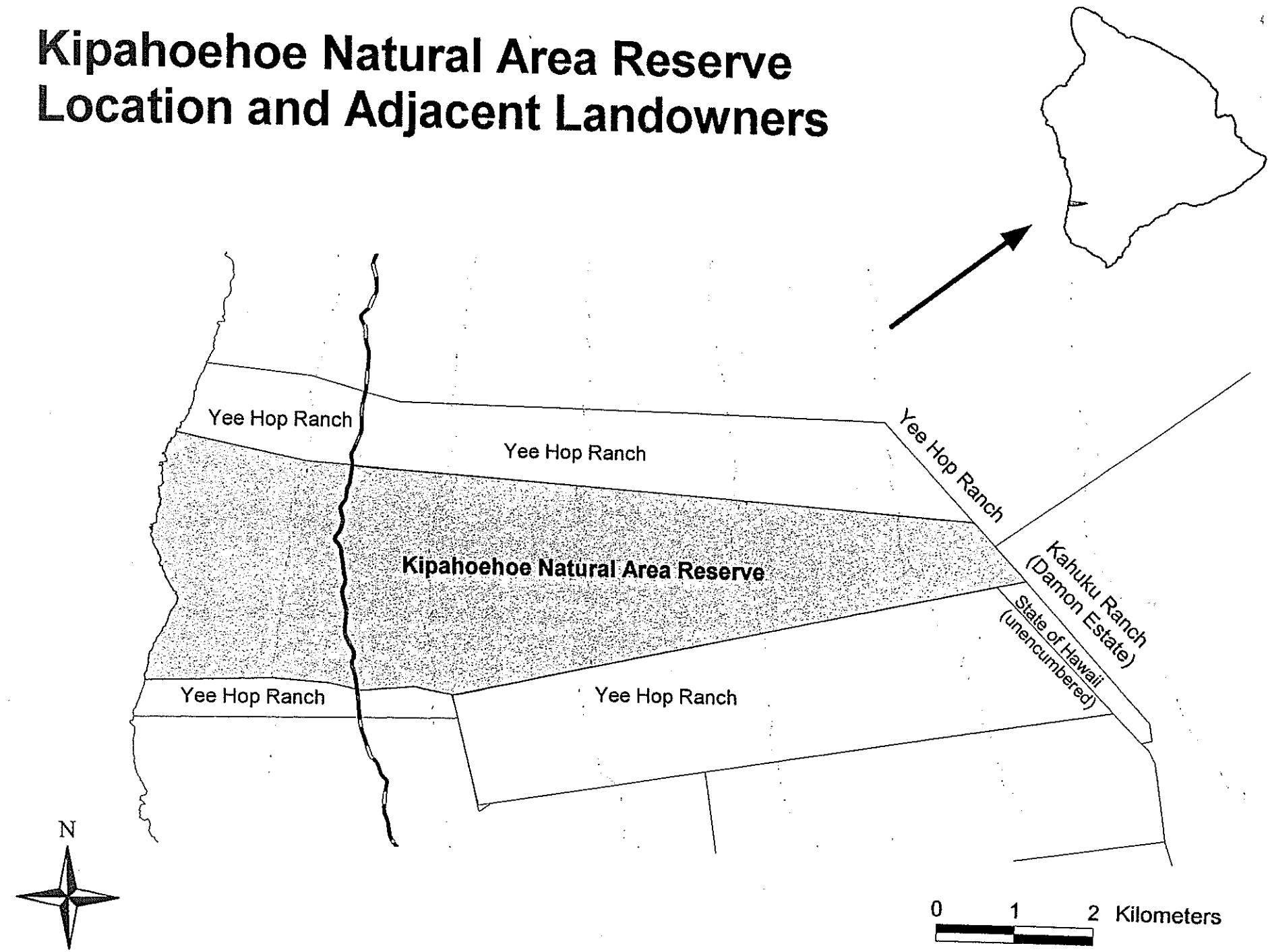
Appendix A

Kipahoehoe Natural Area Reserve Management Plan

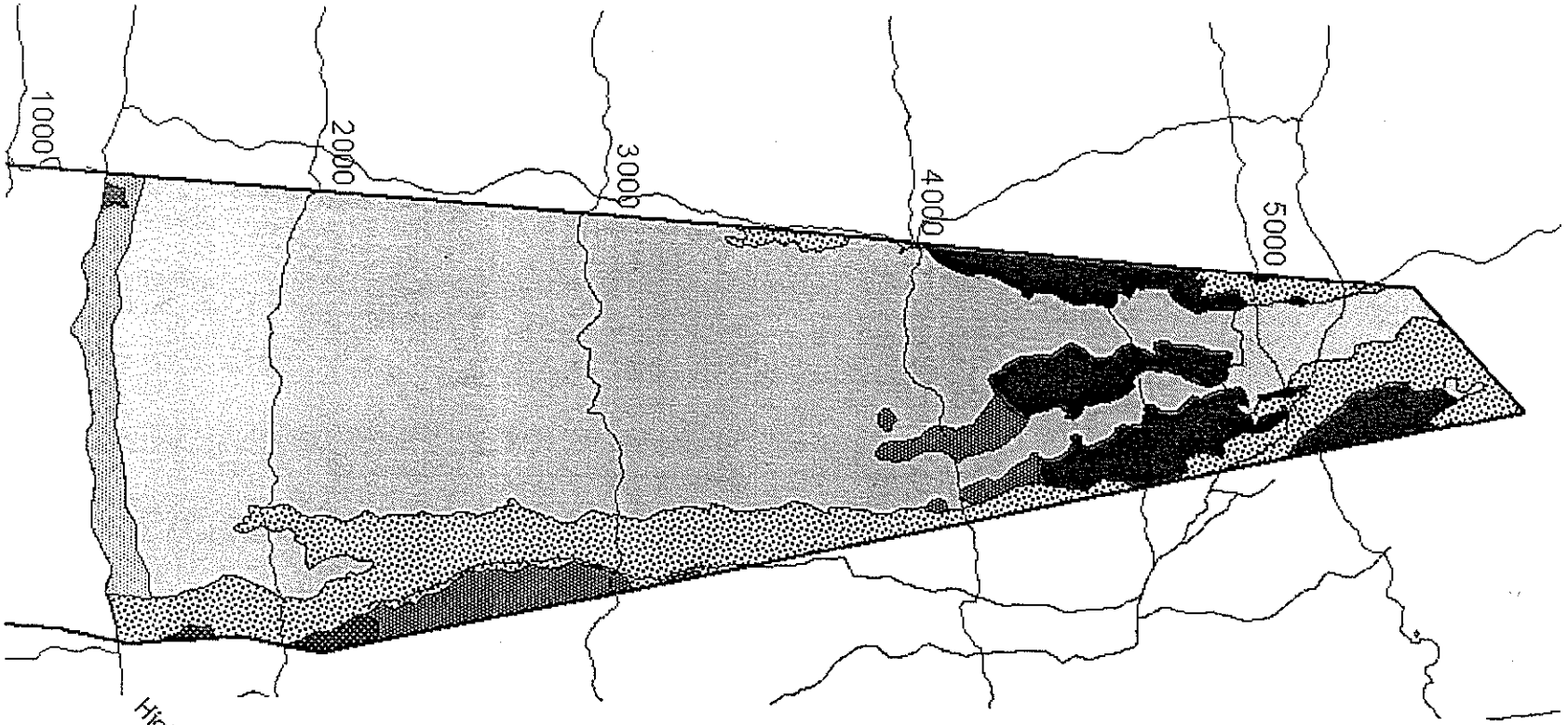
Project Area Maps

- Reserve Location and Adjacent Landowners
- Vegetation Communities
- Management Units and Proposed Fences
- Proposed Internal Road System
- Access Routes
- Possible Public Hiking Trail Alignment

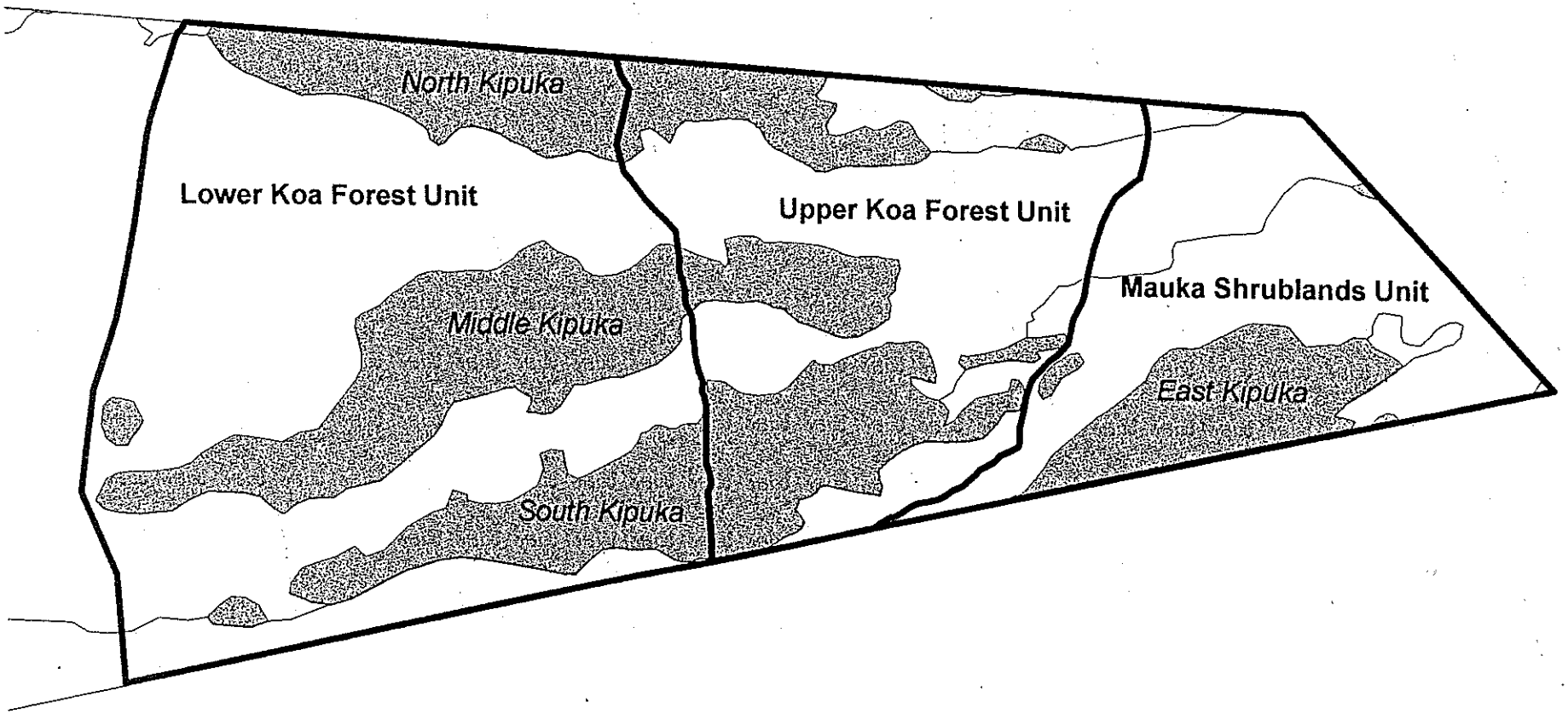
Kipahoehoe Natural Area Reserve
Location and Adjacent Landowners



Kipahoehoe Natural Area Reserve Vegetation Map



Kipahoehoe Natural Area Reserve
Management Units and Proposed Fences



Proposed fence alignments

Kipahoehoe NAR Boundary

200 ft elevation contour

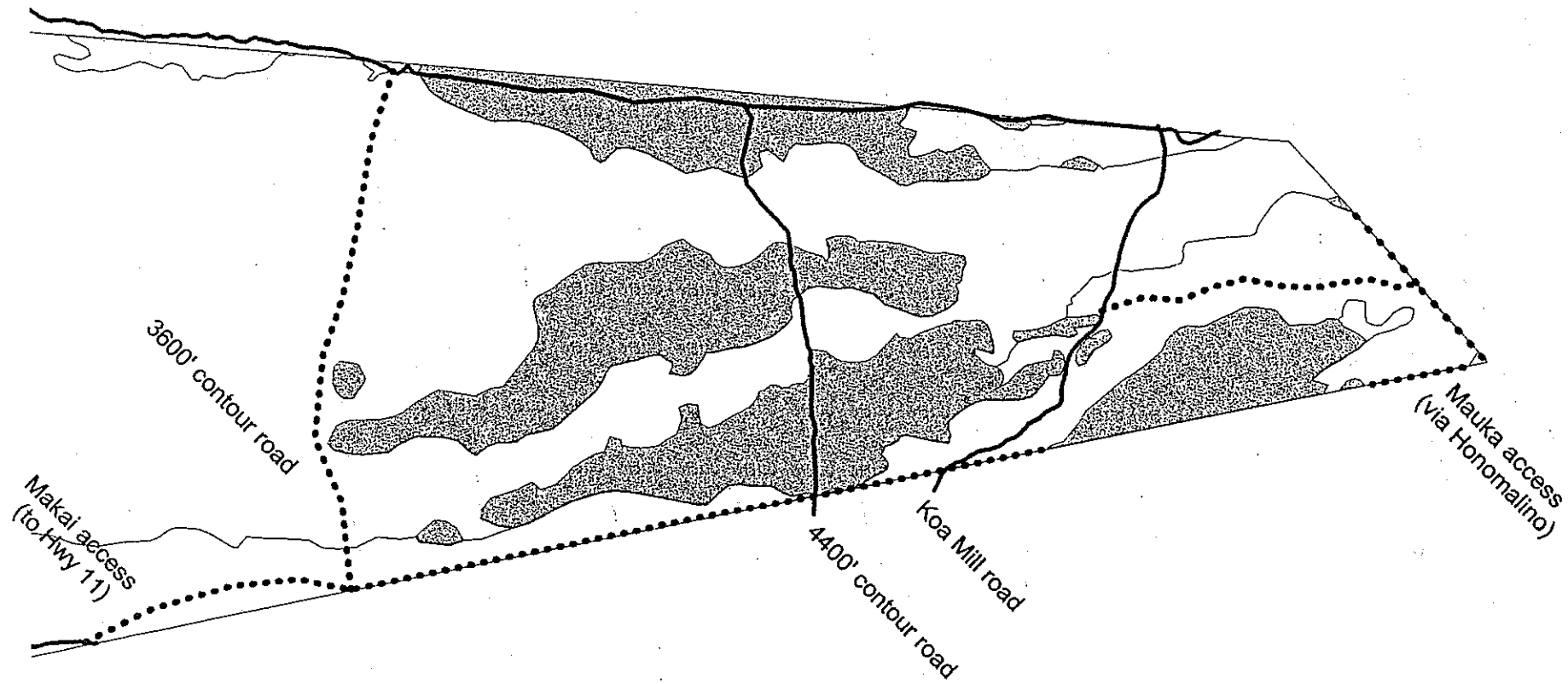
Koa/'Ohi'a Forest Kipuka

Lava Flows of 1919 and 1950

0 0.5 1 Km

N

Kipahoehoe Natural Area Reserve
Internal Road System



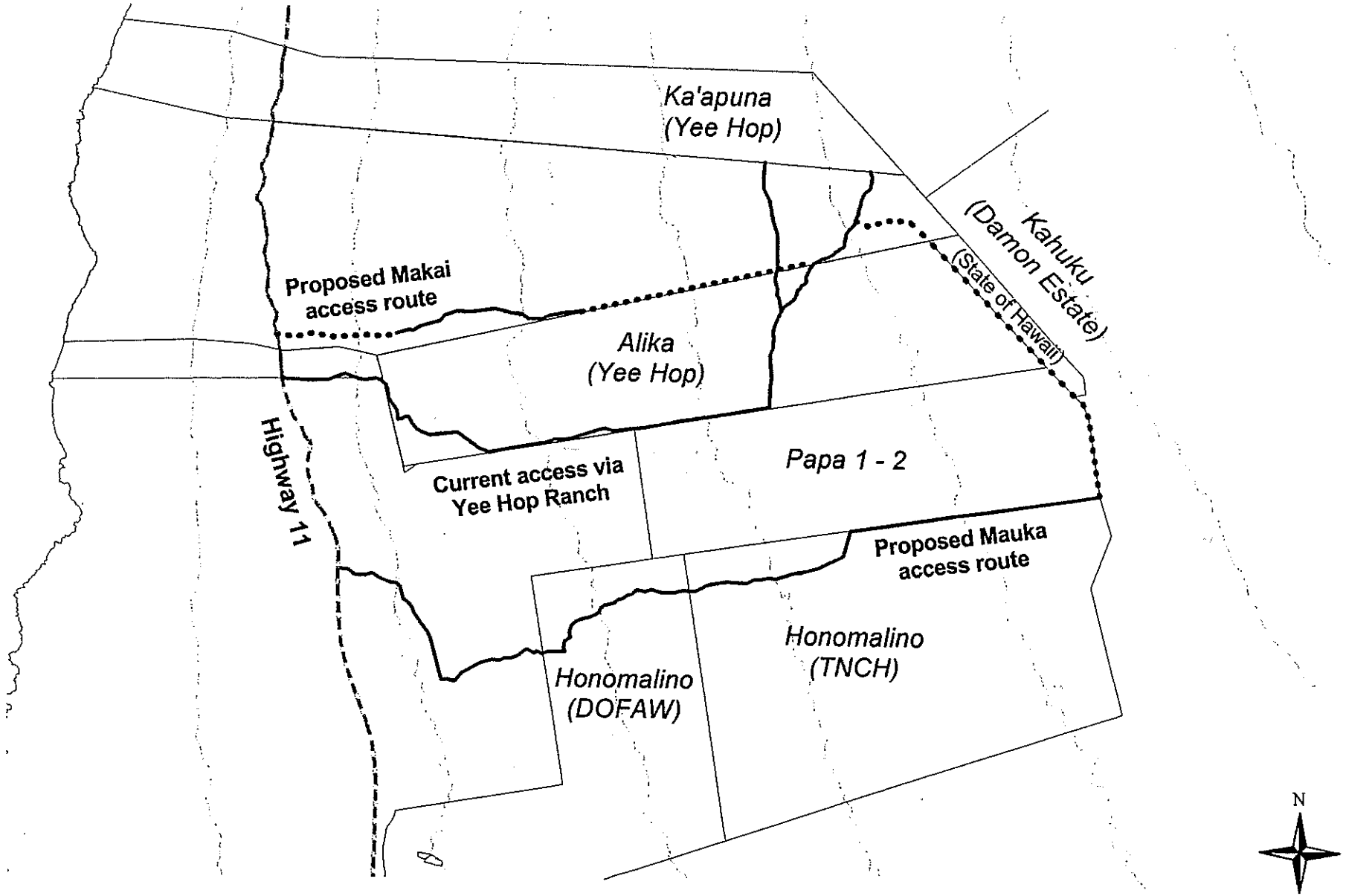
Proposed new roadway
Existing roadway

Kipahoehoe NAR Boundary
200 ft elevation contour
Koa/'Ohi'a Forest Kipuka
Lava Flows of 1919 and 1950

N

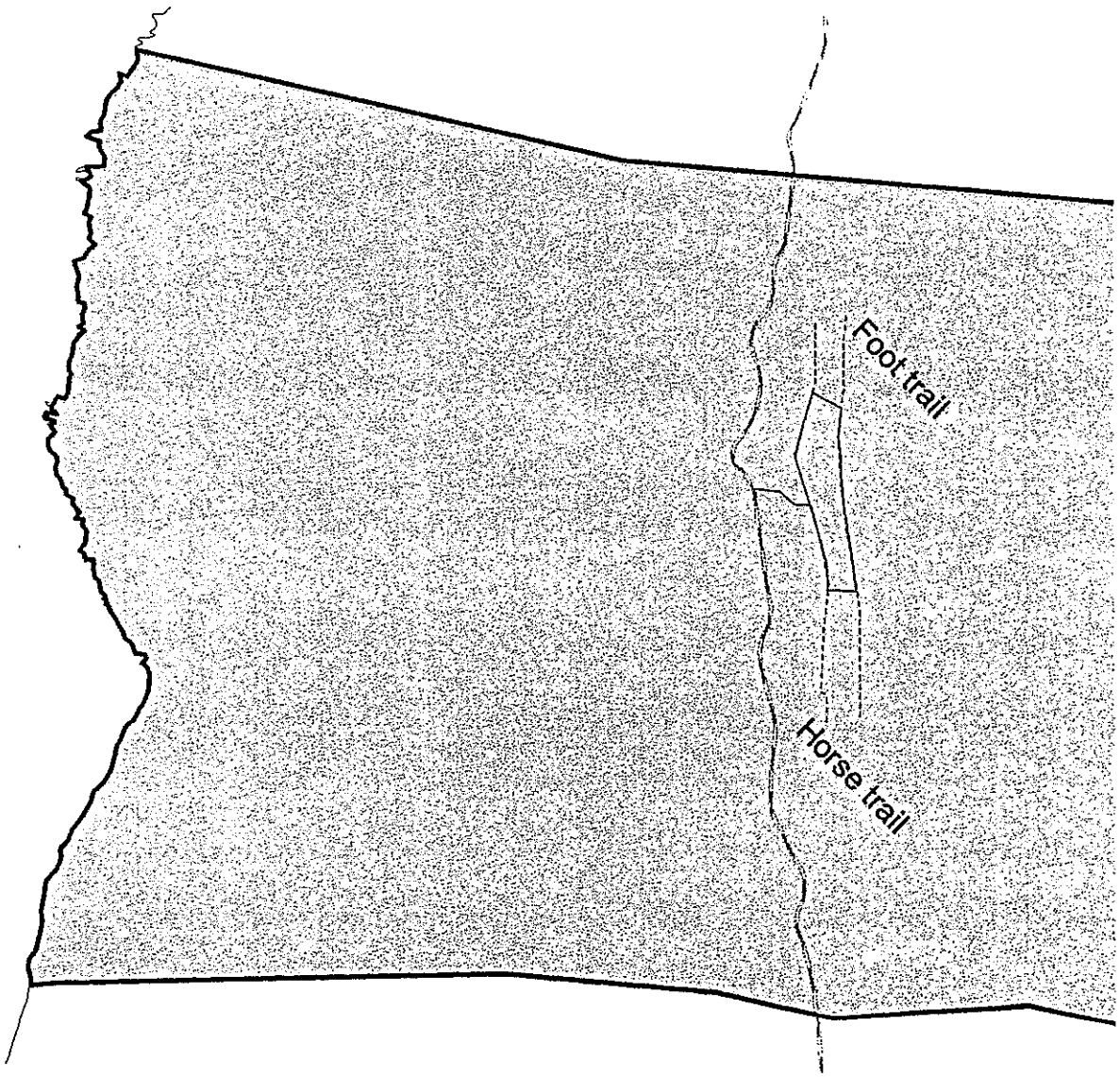
0 1 2 Km

Kipahoehoe Natural Area Reserve
Access Routes



Kipahoehoe Natural Area Reserve

Proposed restoration of historic trails
and development as recreational hiking route



Loop trail to be opened for public use

Approximate location of historic trail remnants

State Hwy 11

N

0 0.5 1 Km

Appendix B

Kipahoehoe Natural Area Reserve Management Plan

Plant Species Checklists

- Native Plant Species
- Non-native Plant Species
- Status of Rare Plants Proposed for Recovery Program

Kipahoehoe Natural Area Reserve
Native Plant Species

Adapted from
Hawaii Branch NARS staff field observations 1996-2000
DLNR/DOFAW 1989 Kipahoehoe Natural Area Reserve Management Plan
TNCH 1989 Kipahoehoe Natural Area Reserve Resource Information

VASCULAR PLANTS

Scientific name	Common name(s)	Listing	Status
Acacia koa	koa		
Agrostis sandwicensis	bent grass		
Alyxia oliviformis	maile		
Antidesma platyphyllum var. platyphyllum	hame		
Astelia menziesiana	pa'iniu, kaluaha		
Bobea timonioides	'ahakea	SOC	?
Broussaisia arguta	kanawao, pu'aha-nui		
Canavalia hawaiiensis	'awikiwiki		
Carex meyenii			
Carex wahuensis			
Cassytha filiformis	kaunaoa		
Cheirodendron trigynum ssp. trigynum	'olapa		
Clermontia clermontioides ssp. clermontioides	'oha-wai		
Cocculus trilobus	huehue		
Coprosma ernodeoides	kukae-nene		
Coprosma montana	pilo		
Cyanea hamatiflora ssp. carlsonii	haha	END	
Cyanea stictophylla	haha	END	
Cyrtandra hawaiensis	ha'iwale		
Deschampsia nubigena	hair grass		
Diospyros sandwicensis	lama		
Dodonaea viscosa	'a'ali'i		
Dubautia ciliolata ssp. ciliolata	na'ena'e, kupaoa		
Dubautia scabra	na'ena'e, kupaoa		
Embelia pacifica	kilioe		
Flueggea neowawraea	mehamehame	END	?
Freycinetia arborea	'ie'ie		
Gahnia gahniiformis	'uki		
Gnaphalium sandwicensium var. kilaueanum	'ena'ena		
Hedyotis centranthoides			
Hedyotis terminalis	manono		
Ilex anomala	kawa'u		
Ipomoea indica	morning glory, koali-awa		
Isachne distichophylla	'ohe		
Labordia hedyosmifolia	kamakahala		
Luzula hawaiiensis var. hawaiiensis	wood rush		
Machaerina angustifolia	'uki		
Melicope clusiifolia	alani		
Melicope volcanica	alani		
Metrosideros polymorpha var. polymorpha	'ohi'a, 'ohi'a-lehua		
Myoporum sandwicense	naio		
Myrsine lessertiana	kolea		

Listing: SOC = Species of Concern T = Threatened END = Endangered

Status: P = Planted, not known to have occurred naturally in Kipahoehoe
? = Historic occurence, not recently observed

VASCULAR PLANTS

Scientific name	Common name(s)	Listing	Status
Myrsine sandwicensis	kolea-lau-li'i		
Nothocestrum longifolium	'aiea		
Peperomia hypoleuca	'ala'ala-wai-nui		
Peperomia leptostachya	'ala'ala-wai-nui		
Peperomia tetraphylla	'ala'ala-wai-nui		
Perrottetia sandwicensis	olomea		
Phyllostegia floribunda	kiponapona	SOC	
Phyllostegia stachyoides	kiponapona	SOC	
Pipturus albidus	mamaki		
Pittosporum hawaiiense	ho'awa		
Pittosporum hosmeri	ho'awa		
Pritchardia schattaueri	lo'ulu	END	P
Psychotria hawaiiensis	kopiko 'ula		
Psydrax odoratum	'alahe'e, walahe'e		
Pycreus polystachyos ssp. polystachyos			
Reynoldsia sandwicensis	'ohe makai	SOC	
Rubus hawaiensis	'akala		
Rubus macraei	'akala	SOC	
Rumex giganteus	pawale, uhauhako		
Santalum paniculatum var. paniculatum	'iliahi		
Smilax melastomifolia	hoi-kuahiwi, aka'awa		
Stenogyne macrantha		SOC	
Stenogyne sessilis	ma'ohi'ohi		
Styphelia tameiameiae	pukiawe		
Tetraplasandra oahuensis	'ohe-mauka		
Trematolobelia grandifolia	koli'i		
Uncinia uncinata			
Urera glabra	opuhe		
Vaccinium calycinum	'ohelo-kau-la'au		
Vaccinium reticulatum	'ohelo		
Xylosma hawaiiense	maua		

FERNS

Scientific name	Common name(s)	Listing	Status
Adenophorus pinnatifidus	palai la'au		
Adenophorus tamariscinus	wahine-noho-mauna		
Asplenium adiantum-nigrum	'iwa'iwa, manawahua		
Asplenium contiguum			
Asplenium horridum	'alae, 'iwa		
Asplenium lobulatum	pi'i-pi'i-lau-manamana, 'anali'i		
Asplenium nidus	'ekaha, bird's-nest fern		
Asplenium trichomanes	'owali'i		
Athyrium microphyllum	'akolea		
Cibotium chamissoi	hapu'u, hapu'u-'i'i		
Cibotium glaucum	hapu'u		
Coniogramme pilosa	lo'ulu		

Listing: SOC = Species of Concern T = Threatened END = Endangered

Status: P = Planted, not known to have occurred naturally in Kipahoehoe
? = Historic occurence, not recently observed

FERNS

Scientific name	Common name(s)	Listing	Status
Dicranopteris linearis	uluhe		
Diplazium sandwichianum	ho'io, pohole		
Doryopteris decora	manawahua, kumuniu, 'iwa'iwa		
Dryopteris fusco-atra	olua,'opeha		
Dryopteris glabra	hohiu, kilau		
Dryopteris wallichiana	lau-kahi, 'i'o nui		
Elaphoglossum crassifolium			
Elaphoglossum hirtum var. micans	maku`e		
Elaphoglossum parvisquameum			
Elaphoglossum wawrae	maku'e		
Grammitis hookeri	maku'e-lau-li'i		
Grammitis tenella	kolokolo, mahinalua		
Lycopodium cernuum	wawae-'iole		
Lycopodium venustulum	wawae-iole		
Mecodium recurvum			
Microlepia strigosa	palapalai		
Nephrolepis cordifolia	'okupukupu		
Nephrolepis exaltata	'okupukupu		
Odontosoria chinensis	pala'a		
Opioderma pendula	puapuamoa		
Pellaea ternifolia	kalamoho, kalamoho-lau-li'i		
Pleopeltis thunbergiana	pakahakaha, 'ekaha-'akolea		
Polypodium pellucidum	'a'e, 'a'ae, ae-lau-nui		
Psilotum complanatum	moa		
Psilotum nudum	moa		
Pteridium decompositum	kilau		
Pteris cretica	'owali,		
Pteris excelsa	waimaka-nui		
Sadleria cyatheoides	'ama'u, ama'uma'u		
Thelypteris globulifera			
Thelypteris hudsoniana			
Thelypteris stegnogrammoides	ho'i'o kula		
Vandenboschia davallioides	palaihihi		

Listing: SOC = Species of Concern T = Threatened END = Endangered

Status: P = Planted, not known to have occurred naturally in Kipahoehoe
? = Historic occurence, not recently observed

Kipahoehoe Natural Area Reserve
Non-native Plant Species

Adapted from
Hawaii Branch NARS staff field observations 1996-2000
DLNR/DOFAW 1989 Kipahoehoe Natural Area Reserve Management Plan
TNCH 1989 Kipahoehoe Natural Area Reserve Resource Information

VASCULAR PLANTS

Scientific name	Common name(s)
Ageratina riparia	spreading mist flower; Hamakua pa'makani
Ageratum conyzoides	maile-hohono
Aleurites moluccana	candlenut, kukui
Andropogon virginicus	broomsedge
Anemone hupehensis var. japonica	
Arundina graminifolia	bamboo orchid
Axonopus fissifolius	narrow-leaved carpetgrass
Begonia hirtella	
Buddleia asiatica	
Caesalpinia major	
Cardamine flexuosa	
Centella asiatica	Asiatic pennywort, pohekula
Cerastium fontanum ssp. triviale	chickweed, hehine-hauli
Cirsium vulgare	bull-thistle, pua kala
Coffea arabica	arabian coffee
Cordyline fruticosa	ti, ki
Cuphea carthagenensis	pukamole, tarweed
Digitaria setigera	mau'u-kukaepua'a, itchy crabgrass
Dioscorea pentaphylla	pi'ia, pi'a, five-leafed yam
Drymaria cordata	pipili
Ehrharta stipoides	meadow ricegrass, pu'u-lehua
Erechtites valerianifolia	
Geranium homeanum	
Gnaphalium purpureum	purple cudweed
Holcus lanatus	velvetgrass, Yorkshire fog
Kalanchoe pinnata	air plant, 'oliwa-ku-kahakai
Lantana camara	lantana, lakana
Melinis minutiflora	molassesgrass
Oplismenus hirtellus	basketgrass, honohono-kukui
Oxalis corniculata	
Paspalum conjugatum	Hilo grass, mau'u-hilo
Paspalum urvillei	vasey grass
Passiflora ligularis	sweet grandilla
Pennisetum clandestinum	kikuyu grass
Persea americana	avocado
Phaius tankarvilleae	Phillipine orchid
Physalis peruviana	poha, Cape gooseberry
Pluchea symphytifolia	sour bush
Prunella vulgaris	self-heal
Psidium cattleianum	strawberry guava, waiawi
Psidium guajava	guava, common guava, kuawa
Ranunculus plebeius	
Rubus rosifolius	thimbleberry, 'ola'a
Sacciolepis indica	Glenwood grass
Schinus terebinthifolius	christmas berry, wilelaiki
Schizachyrium condensatum	

VASCULAR PLANTS

Scientific name	Common name(s)
Senna pendula var. advena	
Sonchus oleraceus	sow thistle, pua-lele
Sporobolus africanus	African dropseed
Stachytarpheta jamaicensis	Jamaica vervain, oi, owi
Vernonia cinerea	ironweed
Veronica plebeia	
Veronica serpyllifolia	
Vulpia bromoides	brome fescue
Youngia japonica	Oriental hawksbeard

FERNS

Scientific name	Common name(s)
Blechnum occidentale	
Deparia petersenii	
Phlebodium aureum	laua'e haole
Phymatosorus scolopendria	laua'e
Thelypteris dentata	pai'i'iha

Kipahoehoe Natural Area Reserve
Management Plan

Rare plant species that may be suitable for recovery/reintroduction efforts in the Reserve

Species (Federal status)	Habitat	Status
Argyroxiphium kauense (END)	montane shrublands	Not recorded from Kipahoehoe, but known from similar habitat in Ka'u and S. Kona.
Asplenium fragile var. insulare (END)	mesic forest	? extant Kipahoehoe (lava tube)
Cyanea hamatiflora ssp. carlsonii (END)	mesic forest	Wild plant found in Kipahoehoe 1995 -- Killed by goats 1999. Outplanted >50 from other sources, more planned.
Cyanea marksii (SOC)	wet forest	Not recorded in Kipahoehoe, extant nearby S. Kona
Cyanea stictophylla (END)	mesic to wet forest	One wild plant in Kipahoehoe, inside temporary fence.
Cytrandra menziesii (SOC)	mesic to wet forest	? extant Kipahoehoe
Dellissea undulata ssp. undulata (END)	mesic forest	Historic record from nearby South Kona
Exocarpos gaudichaudii (SOC)	montane shrublands	S. Kona
Exocarpos menziesii (rare)	montane shrublands	S. Kona and Ka'u
Fragaria chiloensis ssp. chiloensis (SOC)	mesic-wet forest	? extant Kipahoehoe.
Nothocestrum longifolium (rare)	mesic forest	extant Kipahoehoe
Phyllostegia floribunda (SOC)	mesic-wet forest	One wild plant in Kipahoehoe. Cuttings in cultivation
Phyllostegia stachyoides (SOC)	mesic-wet forest	Collected Kipahoehoe 1930
Pittosporum hawaiiense (SOC)	mesic-wet forest	? extant Kipahoehoe
Pritchardia schattaueri (END)	mesic-wet forest	Nearby S. Kona. 6 planted in exclosure fence.

Species (Federal status)	Habitat	Status
Ranunculus hawaiiensis (SOC)	mesic forest	? extant Kipahoehoe
Rubus macraei (SOC)	mesic forest	Extant Kipahoehoe, one population inside fence
Stenogyne macrantha (SOC)	mesic-wet forest	Locally common in Kipahoehoe

SOC = Federal Species of Concern
END = Listed Endangered Species
Rare = uncommon but no legal status

? extant = likely recent observation but not confirmed with voucher

Appendix C

Kipahoehoe Natural Area Reserve
Bird Species Checklist

The birds listed have been reported from visual and audio identification in or near the Reserve. The list includes information on rare birds, compiled from the literature. Taxonomy follows the Checklist of the Birds of Hawaii by Pyle (1988).

Status	Species	Common Name	Source
X	Acridotheres tristris	Common Myna	*
X	Alectoris chukar	Chukar	x
E	Asio flammeus sandwichensis	*Pueo*; Hawaiian owl	?
E +	Buteo solitarius	*'Io*; Hawaiian hawk	*
X	Cardinalis cardinalis	Northern Cardinal	*
E	Chasiempis sandwichensis sandwichensis	*'Elepaio*	*
E +	Corvus hawaiiensis	*'Alala*; Hawaiian crow	?
X	Geopelia striata	Zebra Dove	*
E +	Hemignathus munroi	*'Akiapola'au*	?
E	Hemignathus virens virens	*'Amakihi*	*
E	Himatione sanguinea sanguinea	*'Apapane*	*
X	Leothrix lutea	Red-billed Leothrix	*
X	Lophura leucomelana	Kalij Pheasant	*
X	Meleagris gallopavo	Wild Turkey	x
E +	Oreomystis mana	Hawaii creeper	?
I	Phaethon lepturus dorotheae	*Koa'e kea*; White-tailed tropic bird	*
X	Phasianus colchicus	Ring-necked Pheasant	x
X	Streptopelia chinensis	Spotted Dove	x
X	Tyto alba	Common Barn-owl	*
E	Vestiaria coccinea	*'I'iwi*	*
X	Zosterops japonicus	Japanese White-eye	*

+ = Rare
X = Not Native
I = Indigenous
E = Endemic

* = Confirmed during NARS inventories
x = Cited in literature sources for Kipahoehoe
? = Cited in literature for South Kona area; not confirmed in the Reserve

Taken from Kipahoehoe Natural Area Reserve Resource Information Notebook, prepared by The Nature Conservancy of Hawaii, 1989.